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SCIENCE

C. F. Kettering, retiring president AAAS, who spoke in Boston 27 December

The Future of Science

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SCIENCE

Vol. 104, No. 2713 Friday, 27 December 1946

The Future of Science

C. F. Kettering

Vice-president in Charge of Research, General Motors Corporation, Detroit, Michigan

HAVING SPENT MOST OF MY LIFE in scientific research, invention, and engineering, it is quite natural for me to suggest a long-range look at the operations of our great Association.

One of the functions of research is to study the future, its possibilities, and its problems.

In modern times the search for new knowledge in every field is a continuous process. Only when we have an important emergency, as that occasioned by war, is the normal course of scientific investigation interrupted and its great importance brought to public attention. During such emergencies our efforts must be diverted from the long-range fundamental problems to the short-term immediate problems of supplying the men at the front with the best weapons that the Armed Forces, science, and industry can devise.

World War II in Retrospect

Science played a major part in World War II—a war of science and production, fought for five years in the research laboratories just as it was fought in the factories and at the front. Only you who worked behind the curtain of secrecy realize how important the work of the scientist and engineer was in combating the forces which were sent against us.

This was a war of military and scientific measures and countermeasures. At times these became counter-countermeasures up to the fourth and fifth degree. Frequently our superiority over the enemy was measured only by the speed with which our scientific advancement could be capitalized upon and put into production. The scientist in this war was often called to the front lines to confer with military men, to obtain their reactions firsthand, and even to evaluate or obtain information on the enemy's technical activities. This advancement was possible largely because of our peacetime studies. Discoveries made in some college or industrial research laboratory months or years before the war became very important.

We have lost our continuity in many fundamental fields of scientific investigation. We are now faced with the problem of scientific reconversion—in fact, most of you have gone a long way in returning to peacetime problems. It is natural that, at the end of this break in continuity caused by the war, we review the progress of this organization of scientists during the emergency and then give some thought to our future plans. We have not had such an opportunity for many years. We have been forced out of the ruts of past generations, and we now have an opportunity to make the future anything we wish. I like the name of our organization—The American Association for the Advancement of Science. The word *advancement* implies motion and progress. Our opportunities are so vast that we must make a careful analysis of our past to determine where the need for advancement is greatest. I think we should pick up only what has proven good.

What have we learned out of the war accomplishments of the scientists, teachers, and engineers represented by the membership of the AAAS?

The Mobilization of Science, Education, and Industry

One thing we learned was how to cooperate. To tap our resources of scientifically trained men and their huge storehouse of accumulated scientific knowledge, science was mobilized for war. The technical societies, OSRD, National Inventors' Council, educational institutions, private and industrial laboratories, and the Armed Forces were asked to perform the immediate task of winning the war. Scientists dropped lifetime investigations when it appeared that these would not solve our immediate problems. Large groups were brought together on new projects. The Manhattan District, Radiation Laboratories, and a score of other activities were quickly organized. Everything was done to cash in scientific know-how

Address of the retiring president of the American Association for the Advancement of Science delivered at Boston, Massachusetts, on 27 December 1946.

without thought of cost and little more than a passing thought for the larger, long-range problems of the future.

You, as representatives of the science groups, produced results in every necessary field. To many outsiders these were miracles. New things seemed to spring up overnight. But we know that each miracle was made possible only because of the accumulation of knowledge in the field which comes as a result of our normal, unregimented, peacetime investigations. We must not let the public or the politicians forget this.

With men and organizations that had the training and experience, a whole new family of weapons was developed and soon appeared on the battlefronts. Radar, VT fuses, rockets, gas turbines, synthetic rubber, DDT, high-octane fuels, and a host of others came into tactical use. New equipment was not useful in helping to win the war until it was brought to the front. Here was the problem that our educational system solved. Education was necessary from the factory to the front line. When the equipment was finally turned over to the Armed Services, installers, maintenance men, and operators had to be trained to use new things, some of them entirely foreign to their past experience. Generals and admirals were eager to study the tactical use of new weapons in our fight against a regimented, scientific-minded enemy.

World War II can be looked upon as a dramatic test of the products of our educational and industrial systems over the past 25 years. The huge training programs of the Armed Forces could have been possible only through the fruits of our day-to-day educational and industrial system. Teachers of science, and teachers of science teachers, were as important in carrying out the broad programs as the scientists and engineers themselves. The accumulated experience in methods and techniques developed in our American educational system was called upon. Twelve million men were trained in highly technical fields. Several million were trained for the Army and Navy Air Forces alone, and tens of thousands were trained in the specialized radar and other electronic fields. Thousands of ships were sent out to sea with crews who only a few months previously were cutting hay on the farms, working in our factories, or doing any known peacetime job. These men were quickly trained to use the new scientific equipment developed and manufactured for this war, and the job was well done all along the line.

From this huge wartime training job we learned many things. It is possible to train men faster than had been supposed. New methods and training aids were developed. Paths of improvement in our prewar educational system were demonstrated. The value of close cooperation of the school with the laboratory, factory, repair shop, and the user was proven. Education contributed fully and, in so doing, gained new practical experience. We must not confuse all this training with basic education. Quick, special training can be the result only of long, basic education. We must also recognize that the production of special weapons can be possible only in a country where peacetime production and engineering are fully developed.

It is a common error to assume that such accomplishments as radar, penicillin, high-octane fuels, and atomic bombs are products of our recent conflict—that their development was attributable to the war and took place during that period. Nothing is further from the truth. For instance, penicillin was uncovered by Dr. Fleming in 1929, and one method of production was known before this war. However, the war did accelerate the demand, and new production methods were developed that increased the yield from a given quantity of mold a hundredfold, or 10,000 per cent.

Radar is another example of an idea that was born in the last century and was definitely demonstrated in the early 1920's, when scientists of the Naval Research Laboratories discovered that an object in a radio beam reflected part of the energy back to the transmitter. Long before this war, Admiral Bowen requested that Congress appropriate $100,000 for radar research. The first practical unit was installed in the *USS New York*. Of course, we all know that the Battle of Britain proved the value of British-developed radar as a defense measure, and during the war tremendous strides were made both here and abroad in its development and applications.

What has been true of penicillin and radar also holds good in the cases of other alleged wartime developments, such as synthetic rubber, high-octane fuels, and nuclear power. Of all of these, the last, the atomic bomb, has received the most publicity. Most of us here, I am sure, are familiar with the Smyth report on atomic energy. In this report Smyth mentions the work of Becquerel, the Curies, and Rutherford, extending back into the last century. Dr. Laurence developed the Cyclotron in 1931, Dempster detected U-235 in 1935, and in 1939 Otto Hahn, Strassman, Meitner, and Frisch uncovered the violent type of nuclear disintegration resulting from neutron bombardment of the nucleus of the atom. In the same year, small-scale chain-reaction experiments were performed in American laboratories substantiating the theories. The subsequent wartime developments have been so well publicized as to need no further mention.

I am sure that these few typical examples refute the popular belief that we were an ignorant and ill-prepared nation at the time of Pearl Harbor. Although we were not equipped at that time with a large standing Army, a tremendous Navy, and thousands of combat aircraft, we did have a few things that in the long run proved of tremendous value in winning the war.

Our Backlog of Scientific Knowledge

As I have just implied, we had an excellent backlog of scientific knowledge. Our research organizations were well acquainted with fundamental developments in many fields—developments that would prove invaluable in conducting a war. Furthermore, many industrial concerns had carried these developments beyond the research stage and had actually produced such things as synthetic tires, high-octane fuels, the sulfa drugs, and penicillin. In addition to these, our Armed Forces had developed prototypes of combat aircraft, various types of ordnance, and naval vessels that were ready for the greatly expanded requirements of our Services.

Our System of Mass Production

We had the ability to turn out huge quantities of new things in a relatively short time—a factor that has often been referred to as our "secret weapon," because it was greatly underestimated by our enemies. Over a period of nearly a century and a half America had developed a system of mass production that supplied not only this country, but the world as well, with millions of automobiles, telephones, radios, refrigerators, watches, and hundreds of other things. And, because of the oft-changing demands of the American public, our industries had accustomed themselves to yearly model changes and the incidental annual factory change-over. Through this process American factories developed a production flexibility and "know-how" unequalled by any other country. No other nation could have converted its factories from peacetime production to making airplanes, guns, and tanks as we did in 1942. The mass-production system is to the scientist and inventor what the printing press is to the writer.

The Role of Our Technical Societies

The part played by our technical societies was an important one. Here were organized groups made up of thousands and thousands of the best technical brains in our country. Through these well-established channels the best of our technical knowledge could be mobilized upon short notice. The experience of these thousands from every branch of science—physicists, chemists, metallurgists, and mechanical engineers—could be reached through these societies and focused on the problems of war.

The Role of Our Educators

A factor that has never been accurately evaluated is the tremendous service rendered by our educators during the emergency. Through our principle of "an education for everyone" we evolved in this country the most widespread educational system in the world. Our educators developed a time-tried procedure which has been a decisive factor in our Nation's progress. At the time of Pearl Harbor the entire facilities and experience of this system were mobilized for the Nation's defense, and the problem presented to the educators was a tremendous one, involving as it did the rapid training of technicians in every branch of the Services. Time was not available for the usual four-year courses—the emergency called for months instead of years. The fate of a nation was at stake. But our educators had two things to fall back upon: first, the excellent basic education received by our American youth, and second, a knowledge of the procedure required to solve the problem—education experience.

Today we all know how successfully this program was carried out—our victories attest that. We know the training miracles that were accomplished—how LCT's were navigated across the Pacific by crews of bank clerks and automobile salesmen, how farm boys became bomber pilots, and how others learned to operate and maintain the intricate radar. We have not acquainted the public too well on the point: *it was the educators who brought about this miracle.*

We often hear people express their gratitude for America's natural endowments—its resources of coal, oil, minerals, land, and timber. The backlog of scientific knowledge, our mass-production facilities, our technical societies, and our educational system are rarely considered as resources, yet we know that without them we could never have reached the position we occupy today among the nations of the world.

The Status of Scientific Development

Where are we now on the great road of scientific development? Opinions, of course, will vary all the way from too far to not far enough. Prejudice and facts confuse the thinking of many people. Very many intelligent people, in fact, think science has gone so far that the entire human race is in danger of race suicide. Others think that science, unmindful of the effects of its work on society, should be curbed or limited by some form of legislative regulation. Have we reached a point where we cannot go further because we cannot trust ourselves?

In the enlightenment of modern times it has been

accepted as a matter of course that the pursuit of science by independent research was a worthy endeavor. In our free and independent countries, scientists were encouraged to spend their lives searching for new knowledge. As representatives of this large group of scientists we should resist every attempt to curb the efforts of scientists to find new information. Science must be free. Wherever it has been controlled, it has been only partially productive. In an unsympathetic atmosphere science withers and dies, and all mankind is the loser.

I do not think we are behind because there is so long a time between the discovery of a principle and its utilization in a product. We are just beginning to learn to use science for the benefit of mankind. It was only 125 years ago that Liebig established the first chemical laboratory for the systematic study of that industry. It was in 1800 that Count Rumford started the Royal Institution of London, the first of the organized science laboratories. Industrial research, the application end of science, was not carried out in an organized way until almost the beginning of this century. Even up to World War I there were only a small number of industries which supported industrial research. So, planned scientific research is only 150 years old and industrial research less than 50 years old.

Science has so accelerated human progress in all fields in this short time that it should point the way to increased benefits to more people in the future by the advancement of science.

Nature as a Laboratory

Only 25 per cent of the 2,000,000,000 people of the earth are properly nourished. Only 500,000,000 ever get enough of the proper food. This is not because of natural limitations. We have the scientific knowledge to provide an adequate diet for everyone if the information were properly applied. The false barriers erected by man himself are responsible. The antiquated social systems, ignorance, stupidity, and fear prevent a large percentage of the peoples of the world from enjoying even the most fundamental of the benefits of science.

I believe we know enough to feed the population of the world. But if we do not, we can learn from the green leaf the principles of how to store the energy of the sun and hold it as food. The green leaf is Nature's organic chemical laboratory which takes water from the ground and carbon dioxide from the air to make sugars, starches, and oils. We know little of the process now, but someday we may be able to reproduce it in the laboratory. Radiation chemistry fixes billions of tons of carbon in millions of different compounds without a test tube, Bunsen burner, or burette, while from the photosynthetic storehouse we take 620,000,000 tons of coal and 1,600,000,000 barrels of petroleum in a year. Industrially, we use radiation chemistry to a very small extent. Photography represents most of the man-made radiation chemistry. All of Nature's reactions are made at ambient temperatures and pressures. How did this originate? I would like to see some brilliant young student write a thesis on what was chemically available in prebiological time. We do not yet know the elementary principles.

We know little in this field of photosynthesis. We know that the chlorophyll molecule is not very different from the hemin of the blood. Where there is a magnesium atom in the chlorophyll, there is iron chloride in the hemin. The important difference between a plant and an animal is that the plants are reducers and animals are oxidizers.

Nature has devised a means in the plant of taking two low-energy compounds, carbon dioxide and water, with energy from the sun, to build our entire plant life in all its variations. She did this long before man was in existence. If I were talking to a group of students who had not yet specialized, I would say that life is dependent upon the ability of Nature to use sun energy to convert soda water through the medium of chlorophyll into the foods, fibers, and farm products we need. This is one of the fundamental problems we have yet to solve, and opportunities are as great as man's imagination in this field.

Much has been said about the depletion of our soil. This is a scientific problem of long standing. I believe that, if necessity demands, we can go to our inexhaustible supply of minerals in the sea for all the plant food we will ever need to keep our farm land productive, just as we have gone to the air for nitrogen. Only about 2½ per cent, by weight, of a plant is mineral. We have learned how to obtain salts and bromine from the sea commercially. To obtain millions of pounds of bromine annually from sea water is an important chemical development of the past 25 years. There is one pound of bromine to about eight tons of sea water. What are the chemical reserves of the sea? Each cubic mile of sea water contains 90,000,000 tons of chlorine, 53,000,000 tons of sodium, 5,700,000 tons of magnesium, 4,300,000 tons of sulphur, 3,300,000 tons of potassium, 2,400,000 tons of calcium, 310,000 tons of bromine, and lesser quantities of many other elements, including the trace elements. There are 320,000,000 cubic miles of sea water. Here is a real challenge to future generations to become chemists and engineers of the sea.

Every place we look in Nature we find problems to be solved. Some can be solved in a short time, while others may take generations. There is nothing in research more important than the time factor. Research

must be started years before the results come into general use. Many things, started as much as 100 years ago, have just recently come into use.

Work on synthetic rubber started back in 1826, when Faraday helped to establish that the chief constituent of natural rubber was a hydrocarbon. In 1860 the English chemist, Williams, isolated isoprene from rubber. It was not until World War I that synthetic rubber was produced in small quantity. Continued research produced the synthetic rubber necessary for our use in World War II. It has taken 120 years for the results of research, inventions, and discoveries in the field of synthetic rubber to be brought into general use.

Research is more a process of evolution than of revolution. Progress is slow and occurs in small increments, and long periods of time are involved in new discoveries. The time to lay the foundation for future developments is now.

The AAAS and the Future

With the present position of science in mind, what should be the future policy of the AAAS? What do we mean by advancement of science? What do the members of the Association want it to mean? I have outlined a very few of the things I think it could mean.

Should we be a clearinghouse of information for our members, and merely provide facilities for present activities and various meetings, including the presentation of scientific papers? Certainly these activities in which we exchange information are necessary and desirable—they are the fundamental of our society. This is advancement of science.

Should we have a long-range cooperative program, sponsored by the AAAS, to obtain the information needed to fill in the blank spaces in the many phases of the unknown? I am thinking of the key facts which open up entire new fields of activity. Some time ago I had lunch with a group of my medical friends, who said that, in any field in which many papers were given at a medical convention, it was extremely difficult and time consuming to sift through all the papers to find the important, usable information. One of the men present said that they searched the back publications and plotted number of papers versus time. The point on the curve which represented the present would sometimes be in the hundreds. The curve on the number of papers presented on any one subject would have many high and low points. Obviously, no person could become familiar with them all. As they went back over the curve they looked for the low points. There they found the original discovery that started a whole series of papers. This method of plotting can be applied to any subject. A whole new series of tests and investigations was started by these important pieces of information. It is these key facts which open up entirely new fields of investigation and are responsible for our greatest advances. To put in chart form what we do not know could be equally important in showing where we can have great advancement of science.

Complicated problems involve cooperation between all groups in our society. During the war pure scientists, engineers, chemists, biologists, industries, and educators learned how to work together. The scientist can often help the engineer to solve his problem and vice versa. The entire war effort was an example of the rapid advances in application that could be made only by cooperative effort. We should encourage the interchange of information and learn to use what the other fellow has to offer. This, too, is meant by the advancement of science. But convincing people of the value of a new idea is very difficult. Few people understand the difficulties of getting a new idea started. A friend asked me once what is the first requirement of an inventor. My reply was that he must not bruise easily.

The method of presenting a new idea is one of the important factors in all advancement. The AAAS publications—our permanent record of the progress of the members of the Association—are tools which we can use for the advancement of science. Not many people can hear the papers given; many can be reached by the printed report. There is no reason why our monthly magazine should not become the one authority on the whole field of science for the public at large. If, and this is a big if, we can or will write it so that the average man or student can understand, it would become an important way to advance science. Perhaps we might learn something from the National Geographic Society. Their publication prints more than 1,000,000 copies a month and is the standard authority on many subjects.

Science is not fully advanced when the discoveries are made. There must be a follow-through from the conception of the idea to the experiment, to the device, to the product. It is often just as important for the businessman, the lawmaker, and the general public to know of discoveries in the field of science as it is for other scientists to know of the technical details. We must make the results of science available to all peoples of the world in facts and not in prophecy. A little more scientific public relations would forestall criticism and regulation. Science will be advanced furthest when its results and problems are better known and understood. Our *Scientific Monthly* publishes less than 15,000 copies. That is one copy for a town of 10,000 people, which is not enough. We should aim at a circulation of several hundred thousand.

The advancement of science by its very nature im-

plies education. The war proved the necessity of a population with a good scientific background, from the research scientist to the operator of scientific equipment in the field. We learned many new methods and developed many teaching aids which should be used in our peacetime education. Our continued interest in the field of education is basic to the advancement of science.

At one time many scientists looked to European schools for their postgraduate study. Postgraduate study for research workers, educators, and all scientists who work in creative fields is a necessity. Since many of the past foreign facilities are no longer open to us, I would like to point out a new approach. Let us look to the research laboratories of industries, privately endowed institutions, government, and schools for our future postgraduate work. The shops, the mines, the hospitals, and the hundreds of progressive organizations in our own country offer unlimited possibilities for advanced study. The exchange of men between the various activities of our economy will do much to advance science.

The Universe, including our earth and most of biology, was here and working long before man was here or conscious of the world around him. Science to me is the process by which we can, by cooperation, work to understand the process of Nature. The scientists should be open-minded students sitting in the great classrooms of Nature, listening to her lectures, and using this information to benefit their fellow men. We are still in the kindergarten and should not let our present accomplishments prevent us from seeing how little we really do know and what great opportunities there are for advancement. Here is a limitless field. How can we best use it?

A National Science Foundation?

Philip N. Powers

Scientific Personnel Branch, Office of Naval Research, Navy Department[1]

A CONTROVERSY DEVELOPED AROUND science legislative proposals in the last Congress—a controversy which remained unresolved in spite of compromise and which eventually blocked, for better or for worse, the passage of any of the rival proposals for the Federal support of science. Since then, decisions of a sort have been made on most of the issues originally at stake, and it seems time to take stock of those decisions, to give objective consideration to their wisdom, and to make necessary and appropriate recommendations to the new Congress.

The main issues at stake were:

(1) Shall we have Federal subsidy of basic research?

(2) Shall we have Federal scholarships and fellowships as a means of developing scientific talent?

(3) Granting the need for a National Science Foundation to do these things, shall it be administered by a part-time Board or a single administrator?

(4) Shall this proposed Foundation be asked to coordinate all federally-supported research?

(5) Shall private profit be allowed from patents on discoveries made with public funds?

(6) Shall support be given to basic research in the social as well as the natural sciences?

With the passage of time, these issues are being partially resolved in one way or another as follows:

(1) We now *have* Federal subsidy of basic research on a fairly large scale through the Office of Naval Research in the Navy Department, as well as several of the Bureaus, and through various organizations within the War Department.

(2) We *do not have* Federal scholarships and fellowships (except in a few isolated instances).

(3) The Federal support of basic research is being *administered* by Naval officers, by Army officers, and on a smaller scale by officials in other branches of the Government.

(4) The *coordination* of all research supported by the Army and Navy is to be achieved through a newly-established Joint Army and Navy Research and Development Board under the chairmanship of Vannevar Bush.

(5) There are *no restrictions on patents* of discoveries made while using naval funds except to reserve to the Government a free, nonexclusive license. The policy of the Army is not so clear, but tends to be more restrictive.

(6) Financial support *is being given* for basic research in social as well as natural science.

These issues have given rise to new issues which will again be resolved in one way or another. The important question is whether they will be resolved on the basis of considered opinions of scientists, educators, and others, or whether the whole matter will simply be

[1] The views expressed in this article are personal and not official.

left to resolve itself or perhaps be left to the Army and the Navy to decide in the way that seems best to them.

This present state of affairs cannot be fully understood without giving some consideration to recent events and the conflicting interests which were evident. In chronological order, the outstanding developments during the last two years are believed to be as follows:

November 1944

President Roosevelt addressed four questions to Vannevar Bush relating to: (a) making wartime developments in science known to the world, (b) continuing the "war of science against disease," (c) Federal aid for research activities in public and private organizations, and (d) the discovery and development of scientific talent.

July 1945

Having received the reports of four separate committees, each appointed to study one of the questions, Dr. Bush replied to the President with his now famous report entitled "Science, the Endless Frontier."

Senator Warren Magnuson, of Washington, introduced into the Senate a bill (S. 1285) embodying the principal recommendations of the Bush Report: a part-time Board of scientists to administer a program for the support of basic research in the natural sciences, including medicine, and for the grant of scholarships and fellowships.

Senator Harley Kilgore offered a rival bill (S. 1297), which agreed in (a) its support for basic research in the natural sciences, and in (b) provisions for scholarships and fellowships, but disagreed in its provisions for (c) a single administrator instead of a part-time Board, (d) the coordination of all Federal research, (e) restricting patents on discoveries made with government funds, and (f) the inclusion of the social sciences.[2]

September

In the President's message to Congress, the basic policies of the Kilgore Bill were endorsed.

October–November

Hearings were held before a Subcommittee of the Senate Committee on Military Affairs. Approximately 100 witnesses testified in favor of:[3]

(1) A National Science Foundation	99%
(2) Scholarships and Fellowships	100%[4]
(3) Administration by a	
(a) Single administrator	23%
(b) Some type of board	37%
(4) (a) Some sort of coordination of all Federal research, as opposed to	21%
(b) No coordination	1%
(5) Patent provisions being	
(a) Included	24%
(b) Excluded	23%
(6) The social sciences being	
(a) Included	45%
(b) Excluded, but supported by some other agency	9%

[2] This latter provision did not appear in the original Kilgore Bill but was introduced in a revised version in October 1945.

[3] See "Analytical Summary of Testimony," given in Subcommittee Monograph No. 5 in December 1945. The complete testimony occupies 1,210 pages in a series of six interesting documents entitled, "Hearings on Science Legislation (S. 1297 and Related Bills)," Government Printing Office, 1946.

[4] In the "Analytical Summary of Testimony" it merely states: "The witnesses agreed that there should be a Government financial-aid program for the development of scientific talent," and "There was indeed no opposition."

November

Dr. Isaiah Bowman wrote to President Truman in behalf of the "Committee Supporting the Bush Report."

December

President Truman replied to Dr. Bowman, reaffirming his views as expressed to Congress in September.

On the basis of the testimony, a revised bill, S. 1720, was introduced by Senator Kilgore and others. The Board was strengthened, the patent phraseology was modified, the social sciences were still included, and provisions for a register of scientific and technical personnel and for international cooperation were added.

Under the leadership of H. C. Urey and Harlow Shapley, a "Committee for a National Science Foundation" was formed and issued a statement generally endorsing S. 1720, though not naming it specifically.

January 1946

Senators Thomas, Kilgore, and Magnuson discussed controversial issues with Drs. Bush and Bowman in an effort to revise S. 1720 so that it would be acceptable to all concerned.

February

Under the leadership of Senator Saltonstall, representatives of the Committee Supporting the Bush Report, the Committee for a National Science Foundation, and the American Association for the Advancement of Science met with Senators Kilgore and Magnuson and reached complete accord on a new bill.

This compromise bill, S. 1850, was introduced on 21 February by Senators Kilgore, Magnuson, Johnson, Pepper, Fulbright, Saltonstall, Thomas, and Ferguson.

March

S. 1850 was favorably reported out of the Military Affairs Committee.

April

The Committee Supporting the Bush Report endorsed S. 1850 in a letter to the President and the Congress.

The Council of the AAAS endorsed S. 1850 by a vote of 230 to 10. In behalf of the AAAS, its president, James B. Conant, requested Senators to support S. 1850.

The National Association of Manufacturers announced its opposition to S. 1850.

May

Rep. Wilbur D. Mills introduced H.R. 6448, a bill to establish a Science Foundation along the lines of the original Magnuson Bill. This bill was referred to the Subcommittee on Public Health of the Interstate and Foreign Commerce Committee. Hearings were arranged without inviting or notifying representatives of the Committee for a National Science Foundation or the AAAS. Among those who learned of the hearings and testified in favor of the Mills Bill were representatives of the National Association of Manufacturers, the Committee Supporting the Bush Report, and Dr. Bush.

June

A statement endorsing S. 1850, over the signatures of James B. Conant, George F. Zook, Morris Fishbein, Thomas P. Cooper, Isaiah Bowman, Boris Bakhmeteff, Arthur A. Hauck, Willard A. Givens, and Harlow Shap-

ley, was printed in the *Congressional Record* on 25 June (p. A3929).

July

With its social science provisions stricken from it, S. 1850 passed the Senate by a vote of 48 to 18 and was referred to the House. It died in the Interstate and Foreign Commerce Committee.

The above facts suggest that a National Science Foundation might have been established if there had been sufficient unanimity of opinion among scientists. The breakdown of the compromise agreement, as evidenced by the introduction of, and support for, the Mills Bill, appears to have been an insuperable stumbling block to the passage of any bill. It therefore seems safe to say that in the future *there will be no Science Foundation of any sort without the wholehearted backing of all major groups of scientists.*

There have been some other significant events which help to determine the present state of affairs:

In May 1946 a bill was introduced into the House "To establish an Office of Naval Research. . . .; to plan, foster, and encourage scientific research. . . .; to provide within the Department of the Navy a single office, which, by contract and otherwise, shall . . . obtain, coordinate, and make available to . . . the Navy, world-wide scientific information and the necessary services for conducting specialized and imaginative research; to establish a Naval Research Advisory Committee. . . ." This bill was subsequently passed and, when signed by the President in August, became Public Law 588. Vice Admiral Harold G. Bowen, who had been Chief of the Office of Research and Inventions since its establishment by the Secretary of the Navy in May 1945, now became the first Chief of Naval Research. On 1 November he was retired and was succeeded by Rear Admiral Paul F. Lee.

In May 1946, as part of a War Department reorganization, a new division of the General Staff, G-6, was created to have "primary War Department interest in the application of national scientific resources to the solution of military problems," to advise the Secretary of War and the Chief of Staff on "all War Department matters relating to research and development," to have "over-all War Department responsibility for the initiation, allocation, coordination, and progress of research and development programs," and for other purposes. Maj. Gen. H. S. Aurand was appointed Director of Research and Development.

For the support of *basic* research in universities and industrial laboratories this year, the Office of Naval Research, together with the Naval Bureaus of Aeronautics, Ordnance, and Ships, have about $70,000,000, and the War Department has about the same amount.[5] These figures may be compared with the estimates in the Bush Report for the expenditures of a National Science Foundation during the first year and increasing to a stable level at about the fifth year:

Activity	Millions of dollars	
	First year	Fifth year
Division of Medical Research	$ 5.0	$ 20.0
Division of Natural Sciences	10.0	50.0
Division of National Defense	10.0	20.0
Division of Scientific Personnel and Education	7.0	29.0
Division of Publications and Scientific Collaboration	.5	1.0
Administration	1.0	2.5
	33.5	122.5

From "Science, the Endless Frontier," by Vannevar Bush (p. 33).

Finally, in October, the President established by Executive Order a Scientific Research Board under the chairmanship of Reconversion Director John R. Steelman and composed of the Secretaries of Agriculture, Commerce, Interior, Navy, and War, the Federal Loan, Federal Security, and Federal Works Administrators, the chairmen of the Federal Communications Commission, the Tennessee Valley Authority, the National Advisory Committee for Aeronautics, and the director of the Office of Scientific Research and Development. The Reconversion Director is directed to prepare a report of "(1) his findings with respect to the Federal research program and his recommendations for providing coordination and improved efficiency therein; and (2) his findings with respect to non-Federal research, development and training activities, a statement of the interrelationship of Federal and non-Federal research and development, and his recommendations for planning, administering and staffing Federal research programs to insure that the scientific personnel, training and research facilities of the Nation are used most effectively in the national interest."[6] It is to be noted that this Board has no function except to gather facts and report them to the President.

Coming back now to some of the original purposes of the proposed legislation, it is clear that, although the basic issues remain, new questions have come into focus and must be examined.

The Discovery and Development of Scientific Talent

In a sense, this is the central problem, for without

[5] Figures gathered by the Bureau of the Budget show that for all government research and development work (excluding the Manhattan Engineer District and research in social science) there was appropriated for this fiscal year approximately $712,000,000. This includes about $272,000,000 for the Navy Department and $327,000,000 for the War Department. Carried over from last year, but already obligated, there was $316,000,000 for the Navy, $449,000,000 for the Army, and $67,000,000 for the rest of the Federal Government. Much of this year's appropriation will, of course, not be spent this year, but merely be obligated for expenditure another year.

[6] Executive Order 9791, 17 October 1946.

adequately trained personnel resources, no amount of funds from the Government or from any other source will produce progress in science. On the other hand, well-trained scientists, with an urge to seek new knowledge, will work on in spite of serious handicaps resulting from lack of equipment and funds. This is not to suggest that the equipment is not needed—on the contrary, essential equipment is becoming more elaborate than ever—but it is to point out that the essential ingredient of scientific work is the highly trained human mind.

During and since the war, American policy has tended to ignore this fact. Scientific brainpower has been exploited without regard to its replenishment. We are now faced with an unprecedented scarcity of scientific personnel—the inevitable result of our failure to continue the education of scientists during the war, and this in the face of a rapidly increasing demand for scientific work.

The discovery and development of scientific talent involves not only the problem of demand far exceeding supply but also the over-all status, in quality and diversity of qualifications as well as quantity, of the Nation's scientific manpower resources. We need to know how these resources are presently utilized and the prospect for their continuous development and improvement. It is to be hoped that Steelman's new Scientific Research Board will soon provide much of this information. The magnitude of the problem of discovering and developing scientific talent will then be more clear.

In the Bush Report, the Moe Committee[7] calculated that the normal prewar flow of scientists cannot possibly be regained before 1955 and that during this period an accumulated deficit of at least 16,000 scientists with Doctors' degrees is inevitable. They also reported that in the past the selection of students entering colleges and universities has been primarily on the basis of economic status and not on the basis of talent. It seemed clear that the majority of our ablest high school graduates have been denied college training because of lack of funds and have therefore had no opportunity to become scientists or, for that matter, to enter any of the other professions.

More recently, a committee of the Society for the Promotion of Engineering Education has reported[8] on "The Outlook in the Demands for and Supply of Engineering Graduates." Considering engineers only, their most optimistic figures indicate a cumulative deficit increasing from 25,500 this year to 37,805 in 1949 and then decreasing until the deficit vanishes in 1952.

The need for Federal scholarships and fellowships as well as for other means of developing scientific talent is evidently clear and well established. When testifying on the Kilgore and Magnuson Bills, James B. Conant stated that "those sections which deal with scholarships and fellowships . . . are by far the most important parts of the bill . . . for there is no use considering ways and means of spending money on research unless first-rate men are available to do the work."

With the failure of S. 1850, we still have no organized program in this country for the development of scientific talent. To be sure, there are a few scholarships and fellowships available from private sources, but there are not enough of them. The G. I. Bill will help, but it remains to be seen whether a significant contribution to the development of scientific talent will result. It must be remembered that the training of a scientist to do original work usually requires at least six or seven years.

Our program for the national defense is already handicapped by the shortage of scientists. This is a matter of deep concern to leaders within the Army and Navy who have been given ambitious assignments for the development of novel weapons. Because of this concern, in other parts of the Government as well as in Army and Navy, much-needed programs[9, 10] are under way for improving the employment status of scientists in the Government. The Government hopes thereby to compete more successfully for the ablest available scientists.

As a means of encouraging the development of scientific talent, the Office of Naval Research is also sponsoring an incentive program among high school students. In cooperation with Science Service, outstanding boys interested in the sciences are selected and rewarded with cruises on Navy ships and planes. They are given every opportunity to see the results of scientific research as applied, developed, and used by the Navy. No special effort is made to interest them in the Navy, but every effort is made to stimulate and maintain their interest and enthusiasm in scientific pursuits.

The Army and Navy have no authority to grant the scholarships and fellowships[11] which are needed, but

[7] To assist in answering President Roosevelt's question, "Can an effective program be proposed for discovering and developing scientific talent in American youth so that the continuing future of scientific research in this country may be assured on a level comparable to what has been done during the war?" Dr. Bush appointed a committee under the chairmanship of Henry Allen Moe, secretary-general of the John Simon Guggenheim Memorial Foundation.

[8] In *Journal of Engineering Education,* September 1946, p. 25.

[9] See M. H. Trytten on "The Advisory Committee on Scientific Personnel," *Science,* 1946, **103**, 437.

[10] See Philip N. Powers on "The Science Training Group in the Washington Area," *Science,* 1946, **104**, 477.

[11] Some of the research contracts with universities have indirectly provided the equivalent of fellowships, however.

it is of interest to note the recently announced Holloway Plan. Financial support is provided for superior college students, enrolling in any one of a large number of selected colleges, who wish to become naval officers. There are sufficient funds available on a competitive basis so that approximately the top 5 per cent of the Nation's high school graduates now have an opportunity to receive tuition plus $50 per month while in college and then become regular naval officers for at least one and a half to three years. This is an excellent way to ensure the quality of our future Navy, but it makes it more than ever essential that, for this same top 5 per cent, *similar opportunities to go to college be offered to those who prefer to enter the scientific as well as the other professions.*

Federal Support for Basic Research

American science can take little pride in its past performance of basic research.[12] We have, to be sure, been pre-eminent in the application of fundamental knowledge to practical problems, but a large proportion of the original discoveries were made abroad. The numbers of Nobel prizes awarded in this country compared with those awarded abroad offer some indication of the extent to which we have been dependent on foreign scientists for the discovery of fundamental knowledge. In the fields of physics, chemistry, medicine, and physiology the ratio is approximately 1 to 6. Were it not for the internationalism of science, our American science might have been badly off indeed.

During the war years, very little basic research was done anywhere. Instead, there has been extensive exploitation of fundamental knowledge gained before the war. Scientific work has been out of balance and will become increasingly hampered unless the flow of fundamental knowledge is resumed. This is a challenge to American science to see whether it has sufficiently matured to assume its proper role in the world. There are indications that this is not yet to be the case, but we have an unprecedented opportunity. Many of the outstanding European scientists have come to this country, and we are one of the few countries having the wealth to provide the elaborate equipment frequently needed for atomic age research.

The need for encouragement of basic research was one of the primary inspirations of S. 1850. But there was some disagreement about the desirability of asking the Government to provide such encouragement, and considerable dispute about how public funds for basic research should be administered.

While this dispute was going on, the Army and the Navy, well aware of the necessity for the support of basic research to preserve national security, embarked on programs of their own without waiting for the establishment of a National Science Foundation. The Navy took the lead with its Office of Research and Inventions and its request for legislation for a permanent Office of Naval Research. As a consequence, we have large-scale Federal Support for basic research after all, and we may ask how it is working out.

Shall we be thankful that the military stepped in to do a job that we have been otherwise unable to accomplish? Is the job being done in a way which can be wholeheartedly endorsed and approved by American scientists? How have last year's disputes over administration, patents, and social sciences been resolved? To attempt full answers to these questions would be to anticipate the report of the Steelman Scientific Research Board without the necessary facts to do so. It is highly appropriate to comment at this point, however, that the administration of funds through the Office of Naval Research has thus far been widely acclaimed. The Navy has exhibited a remarkably clear understanding of the necessity for freedom of scientific research. For example, Capt. R. D. Conrad, director of ONR's Planning Division, recently remarked:[13] "It is the responsibility of all of us to be vigilant that Government aid to research shall be in the true spirit of science, whether the funds are administered by the present Government Departments or by a National Science Foundation of the future."

There are other questions: *Should Congress establish within the War Department a counterpart to the Office of Naval Research? Assuming that funds are being administered "in the true spirit of science," can we expect this state of affairs to continue? Is it proper for military funds to be used for research which has no specific military objective?* With respect to the last question, Capt. Conrad also stated: "The responsibilities of the Navy for the national security justify the expenditure of naval funds for [basic] research. . . ."; and on another occasion:[14] "It will be a long time before a National Science Foundation can be enacted into law, staffed, supplied with funds and opened for business. In this critical interval, the Armed Services are providing the support so essential to science." Also, Capt. M. J. Lawrence, the Assistant Chief of ONR, stated:[15] "The Navy is in favor of the proposed National Science Foundation and we feel that if and when such an agency is set up it will certainly take over some of the [basic research] programs now being sponsored by us."

[12] See K. T. Compton on "Science and National Policy," *Scientific Monthly*, August 1946, p. 125.

[13] Navy Day address at the University of Illinois, 27 October 1946.

[14] In an address read for Capt. Conrad by Cdr. P. K. Wells before the Commonwealth Club of California in San Francisco on 6 December 1946.

[15] Before the Indiana Academy of Science in Terre Haute on 18 October 1946.

For the time being, American science is apparently receiving more support for basic research than ever before. We have part of a National Science Foundation after all, and we are gaining experience[16] which will be invaluable in further planning for a permanent Foundation. At this point it must be remembered, however, that the easiest thing for Congress to do is nothing. The Army, as well as the Navy, has officially[17] supported a National Science Foundation, and if scientists, educators, and others throughout the country fail to support this view, thereby failing to assume responsibility for encouraging the promotion of science for peaceful purposes, then there is another question to be faced: *Is the primary end of free American science to be the national defense—free because of the necessity of fundamental discoveries leading to novel weapons of war?*

[16] For example, with admittedly less than a year's experience in contracting for basic research, the Office of Naval Research has not had a single patentable discovery brought to its attention. This suggests that last year's controversy over patents was all out of proportion to its importance. Indeed, this is not surprising because the fundamental knowledge resulting from basic research is rarely patentable.

[17] Except for the patent provisions, S. 1850 was supported by the War and Navy Departments in letters to the Chairman of the Senate Committee on Military Affairs during April 1946.

Technical Papers

The Role of the Liver in Guanidoacetic Acid Metabolism in Man

HENRY D. HOBERMAN, CHARLES W. LLOYD, and ROBERT H. WILLIAMS[1]

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The experimental production of pathologic changes in the liver of rats, rabbits, and dogs by the restriction of dietary methyl (*1*) groups suggests that a study of methylation processes in patients with cirrhosis may yield information of value. Najjar, *et al.* (*7*) claim that there is a reduction of the excretion of N^1 methylnicotinamide (F2) in patients with liver disease after the administration of nicotinamide. However, Perlzweig and Huff (*8*) have shown that the excretion of F2 is the resultant of two or more metabolic reactions involving nicotinamide, methylation, and the conversion of F2 to products the natures of which are unknown. McKibbin, *et al.* (*6*) were unable to demonstrate decreased excretion of F2 in dogs after the production of fatty livers by a choline-free diet.

It is probable that this problem could be approached more directly by studying the methylation of guanidoacetic acid to creatine. It is now presumed that guanidoacetic acid is synthesized in the kidney from arginine and glycine (*2, 3*), and that its methylation to creatine occurs in the liver with methionine, or with the system of choline + homocystine (*5*) acting as methyl donors. Creatinine containing a deuteriomethyl group has been isolated from normal human urine after the administration of methionine containing a deuteriomethyl group (*9*).

From the observations of Block and Schoenheimer (*2*) the conclusion is drawn that approximately 2 per cent of the creatine depot of the rat undergoes daily turnover. This value corresponds well with the amount of creatinine excreted in the urine per day. It was also demonstrated that, as far as is known, there is but a single pathway in the metabolism of guanidoacetic acid, namely, its conversion to creatine and thence to creatinine. Therefore, if it is assumed that in man the amount of creatinine excreted daily is replaced in the body by an equimolar amount of creatine, synthesized from equimolar amounts of guanidoacetic acid and methyl groups, a quantitative estimation of the urinary excretion of guanidoacetic acid and total creatinine should be informative in determining the extent of this transmethylation reaction. This process has the significant advantage that the transformation of guanidoacetic acid to creatine normally reaches 95 per cent of completion in man, *i.e.* the amount of guanidoacetic acid in the urine is equal to approximately 5 per cent of the sum of the total amount of creatinine + guanidoacetic acid (see below). Therefore, small deficiencies in the conversion of guanidoacetic acid to creatine should be reflected by relatively large increases in the excretion of guanidoacetic acid in the urine.

We have found in 15 determinations (*4*) on 8 men that the ratio $\frac{\text{mg. guanidoacetic acid}}{\text{mg. total creatinine + guanidoacetic acid mg.}}$ (guanidoacetic acid index) in the urine of normal male adults on an unrestricted diet is in the range 0.03–0.05, with an average value of 0.043 + 0.006. The excretion of guanidoacetic acid by the normal female

[1] The authors are very grateful for the aid given by Mrs. Gloria K. Peacock.

has been found to be related to the menstrual cycle, with maximum excretion in the urine occurring at midcycle. The guanidoacetic acid index of 10 male patients with cirrhosis of the liver was found to be between 0.040 and 0.17, and appears to be related to the degree of cirrhosis as approximated by the usual clinical criteria.

The impression gained above, namely, that in human cirrhosis a deficiency of methylation of guanidoacetic acid may exist, was confirmed by comparing guanidoacetic acid indices of normal men and men with cirrhosis after either the oral or intravenous administration of guanidoacetic acid. Patients with cirrhosis tended to show significantly higher elevations of the guanidoacetic acid index than did the normal controls. The administration of methionine before giving guanidoacetic acid has, as yet, given only equivocal results.

Results of these investigations will be submitted in detail in a future publication.

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An "Invisible" Chromosome [1]

M. Kodani and Curt Stern

Department of Zoology, University of Rochester

Males of *Drosophila melanogaster* were X-rayed with a dose of 4,000 r, and their offspring investigated genetically for the presence of induced chromosomal rearrangements. Among such rearrangements one called $R^3(+)$ originated in consequence of at least four breaks in the left arms of chromosomes 2 and 3 and in the right arm of chromosome 4 (*2*). These breaks and the resulting rearrangements will not concern us here. In addition, two more breaks occurred in the right arm of chromosome 3, causing a deficiency for the region 95D/E–97C1, as defined in Bridges' map of the salivary gland chromosomes. As a result of the deficiency, the region 95D/E–97C1, present in the normal homologue of the deficient chromosome, forms a typical unpaired loop (Fig. 1). No flies have been found which are genetically deficient for this region, since every individual carrying a deficient chromosome also contains the excised fragment. Larvae carrying one or two 95D/E–97C1 fragments, in addition to one or two undeleted chromosomes 3, are viable. In the salivary gland nucleus the fragment is found deeply imbedded in the chromocenter with its 95D/E end, and the other 97C1 end often likewise attached to the chromocenter. In this case the fragment forms a short loop; otherwise it ends freely.

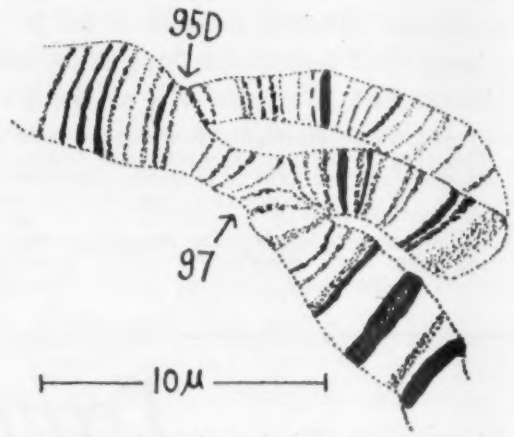

Fig. 1. A region of chromosome 3 of an individual heterozygous for a normal chromosome and one deficient for section 95D/E–97C1.

The rearrangement, including the fragment, is distributed independently of sex, *i.e.* the fragment is not linked with either the X- or Y-chromosome. Cytogenetic studies show further that the fragment is distributed at random with respect to the autosomes, *i.e.* it represents an independent chromosome. Clearest proof for this statement is seen in the following results: A male heterozygous for the $R^3(+)$ rearrangement and a set of normal chromosomes was crossed to a female with normal chromosomes. Salivary gland nuclei of six F_1-larvae from this cross were shown to contain three of the four possible viable combinations of the $R^3(+)$ rearranged large autosomes, the normal large autosomes, and the fragment. Of the six larvae, two had obtained from the P ♂ the rearranged autosomes plus the fragment; three, the rearranged autosomes without the fragment; and one, the normal autosomes without the fragment. Among the offspring of a normal female and another male which itself had received the $R^3(+)$ rearrangement from one of its parents, and, from its other parent, a chromosome 2 carrying an inversion as well as a normal chromosome 3, the following types of constitutions were found: two larvae without the $R^3(+)$ rearrangement but with the 95D/E–97C1 fragment, and one larva likewise without the $R^3(+)$ rearrangement and lacking the fragment.

The origin of the kinetochore to which the fragment presumably has been joined is not known with cer-

[1] Supported in part by a grant from the Rockefeller Foundation.

tainty. It may be assumed that the proximal end of the fragment is translocated to a base of chromosome 4. It is known that the origin of the $R^3(+)$ rearrangement involved at least one chromatid of chromosome 4R, breaking it near its base and translocating to it the tip of chromosome 3L. It is possible that the two bases of chromosome 4 required by the hypothesis originated as a result of breaks induced in the two chromatids of this chromosome which were transmitted by the irradiated sperm. It is not clear how the 97C1 end of the fragment terminates. Its tendency to synapse with the chromocenter brings to mind the capacity of chromosome 4R to join the chromocenter with both its ends. The possibility is suggested that the fragment became inserted in a chromatid of 4, which itself became deleted of nearly all of 4R excepting the base and very tip.

The most remarkable property of the chromosome fragment is its invisibility in metaphase plates of ordinary mitosis, either of ganglion cells, cells of imaginal discs, or oogonial cells. In order to prove simultaneously the presence of the fragment and its invisibility, nuclei of salivary glands and of mitotic ganglionic cells were studied from the same individual larvae. In two cases satisfactory preparations were obtained. One larva, in its salivary gland nuclei, exhibited normal chromosomes X, 2, and 3 in diploid condition, a single chromosome 4, plus the 95D/E–97C1 chromosome (Fig. 2a). In its ganglionic metaphases were visible two normal chromosomes each of X, 2, and 3 and a single chromosome 4, but no further element could be seen (Fig. 2b). In the second larva two X-chromosomes, a normal chromosome each of 2 and 3, and the rearranged chromosomes 2 and 3 were found both in salivary and ganglionic nuclei, as well as two normal chromosomes 4, and the base 4, tip 3L unit. The salivary cells showed, in addition, the presence of the 95D/E–97C1 chromosome. Again, the ganglionic nuclei did not exhibit an element corresponding to this chromosome.

Apparently the 95D/E–97C1 chromosome element is too small to be visible in mitotic divisions, at least with the aceto-orcein method used in both temporary and permanent preparations. The possibility of the existence of chromosome fragments beyond the limit of visibility in mitotic divisions had been considered before by Neuhaus (*1*), but correlated study of salivary nuclei was possible in his cases. Without the investigation of the giant nuclei of the salivary glands, the existence of the "invisible" chromosome in the $R^3(+)$ rearrangement likewise would have remained unknown.

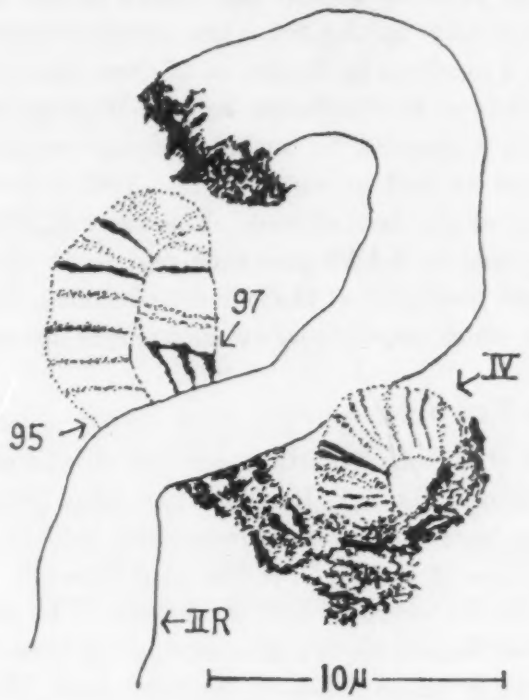

FIG. 2a. Part of the salivary chromosomes of a larva possessing normal diploid chromosomes X, 2, and 3, a single chromosome 4, and the 95D/E–97C1 element.

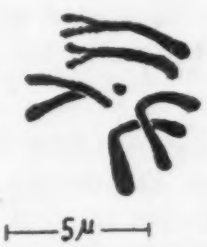

FIG. 2b. Metaphase figure from a ganglion cell of the same larva. No chromosome corresponding to the 95D/E–97C1 element is visible.

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News and Notes

A new prize of $1,000 was added to the awards made annually by AAAS when announcement was made at a luncheon in Boston on 27 December that the AAAS-George Westinghouse Science Writing Awards had been expanded to include science writers for magazines as well as newspapers. 1947 will be the first year of the dual contest. The other $1,000 prize administered by AAAS goes each year to an outstanding paper presented at the scientific sessions, the support for which comes from an anonymous donor.

About People

Loren P. Woods, assistant curator of Fishes, Chicago Natural History Museum, has been granted a two-year leave to accept a temporary post as associate curator of Fishes, U. S. National Museum, Washington, D. C., where he will work with L. P. Schultz, curator of Fishes, on the classification of some 40,000 specimens of shore fishes of the four main Marshall Islands, collected before and after the atomic bomb tests at Bikini.

Ford M. Milam, formerly a research assistant at North Carolina State College and more recently in the Army, has been appointed director of Agricultural Experiment Stations in the American zone of Korea.

Aubrey I. Brown has been made head of the Department of Mechanical Engineering, The Ohio State University. Prof. Brown succeeds Franklin W. Marquis, chairman since 1929, who has resigned to devote his full time to teaching. The new department head, who was graduated from Ohio State in 1912 and has been on the staff continuously since 1913, is a specialist in research and development of heating, air-conditioning, and ventilating equipment.

Curtis L. Newcombe has resigned as director of the Virginia Fisheries Laboratory, Williamsburg, to join the staff of the Cranbrook Institute of Science, Bloomfield Hills, Michigan, as zoologist.

Otis K. McMahon, formerly industrial psychologist of the American Optical Company, has been appointed by Rohrer, Hibler & Replogle as staff psychologist attached to the Chicago office.

National Rubber Research at Stanford University

Stanford University has received a grant of approximately $150,000 from the Office of Naval Research for an eight-month project on natural rubber. The project, to be carried on at Salinas, California, and in the University's laboratories, will be administered by the newly-established Stanford Research Institute.

William F. Talbot, director of the Institute, explained that the aim of the research program will be to develop sturdier, more productive rubber-yielding plants than can now be grown in the United States so that in the event of another national emergency, the country would not be short of potential natural rubber supplies.

Facilities to be used in the project include four government-owned laboratories at Salinas and 340 acres of farm land there, now planted with a wide variety of guayule strains.

Stanford is canvassing the United States and foreign countries for scientific specialists to staff the project. Scientists engaged in the project will seek improved strains and hybrids of guayule and other plants, and will seek to develop plants with a higher rubber content, which will grow more rapidly and sturdily and will be at home even in poor soil. The scientists will also attempt to discover more efficient and economical processes of separating the rubber from other plant material, with an end-product higher in quality than is now possible.

The Salinas laboratories, where guayule research was carried on during the war, are extremely well equipped and are supplemented by an administration building, ample storage facilities, and necessary agricultural equipment.

Work on the project, which is already under way, will continue under the present grant until 1 July 1947.

Personnel engaged in the project, including scientists, administrators, and agricultural workers, will number from 50 to 60.

Reed C. Rollins, Stanford assistant professor of biology, who was with the Government's special guayule project until its curtailment, will be in charge of the plant improvement program; D. U. Gerstel, University of California expert on plant genetics, has been appointed to the Research Institute staff for work on the project; and W. E. Rand, formerly of the Sun Chemical Corporation of New York City, is already at work as project manager and chemical engineer.

The majority of the research work will be carried on in the Salinas laboratories. The rest will be done in the laboratories of the Stanford School of Biological Sciences and of the Department of Chemistry, which will cooperate in the project.

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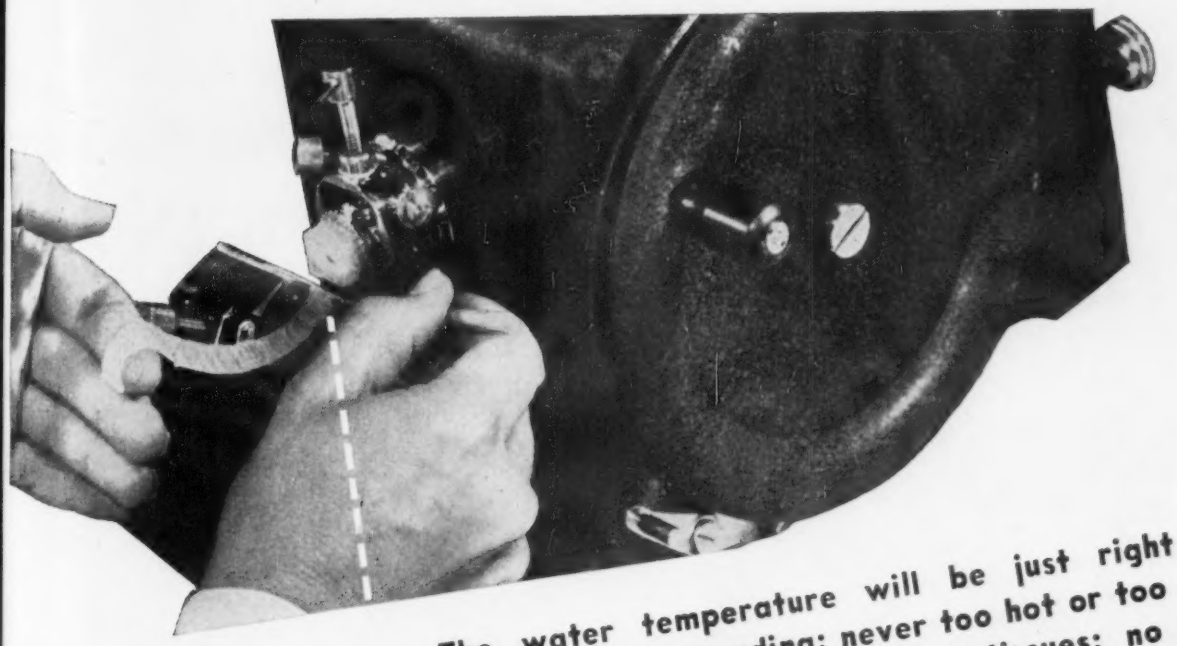

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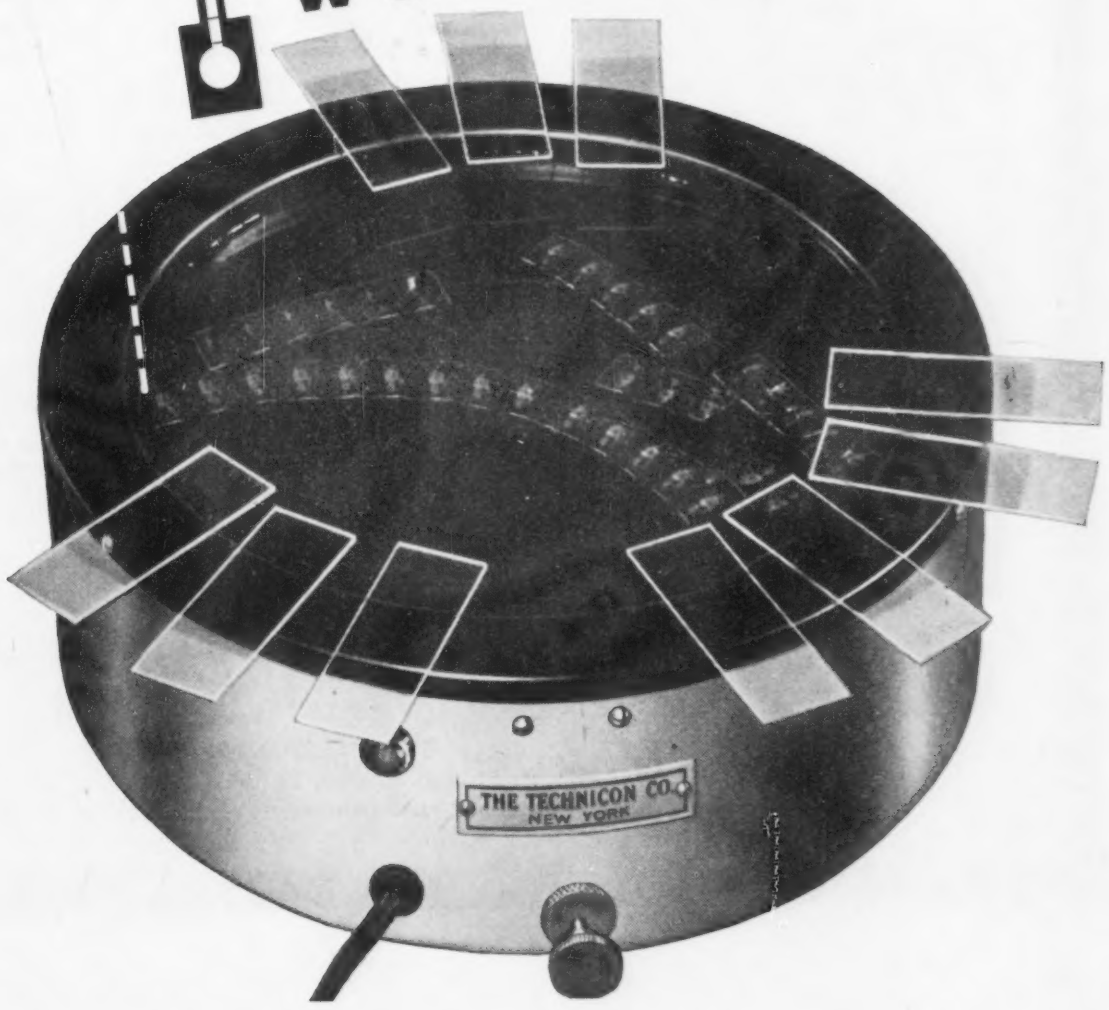

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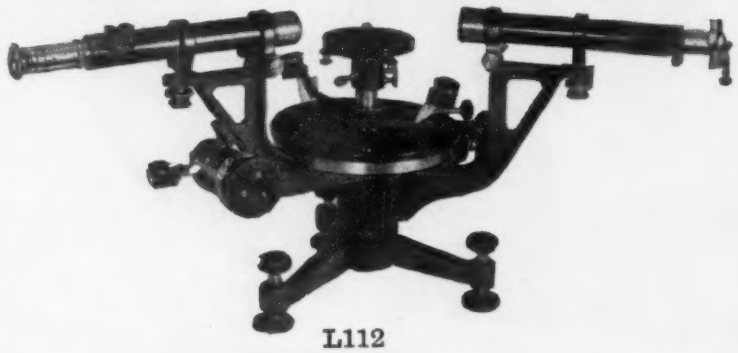

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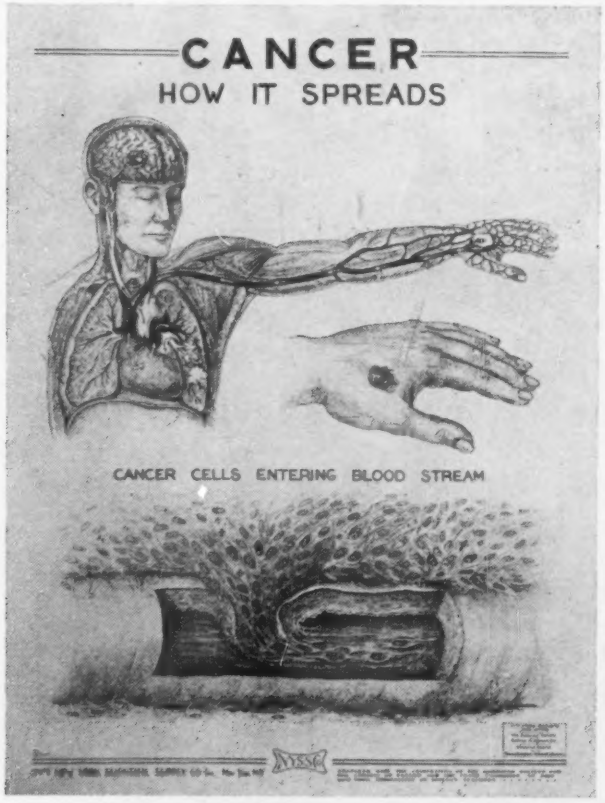

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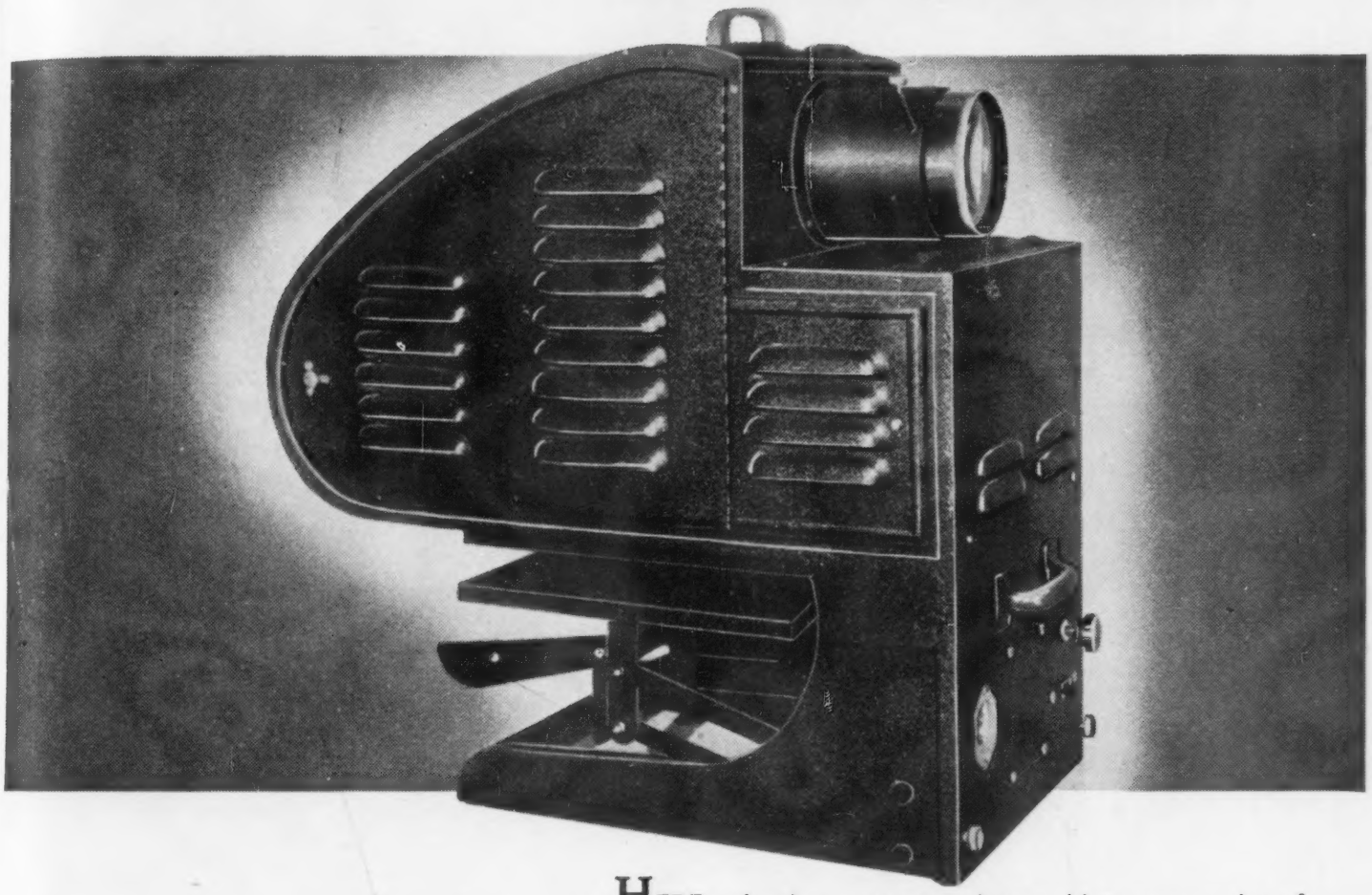

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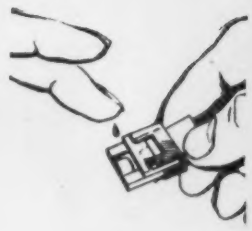

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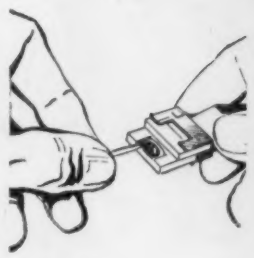

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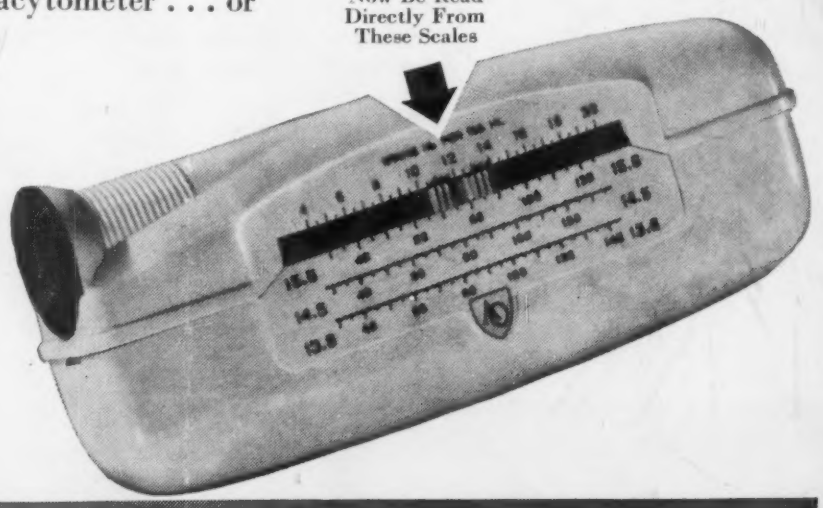

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